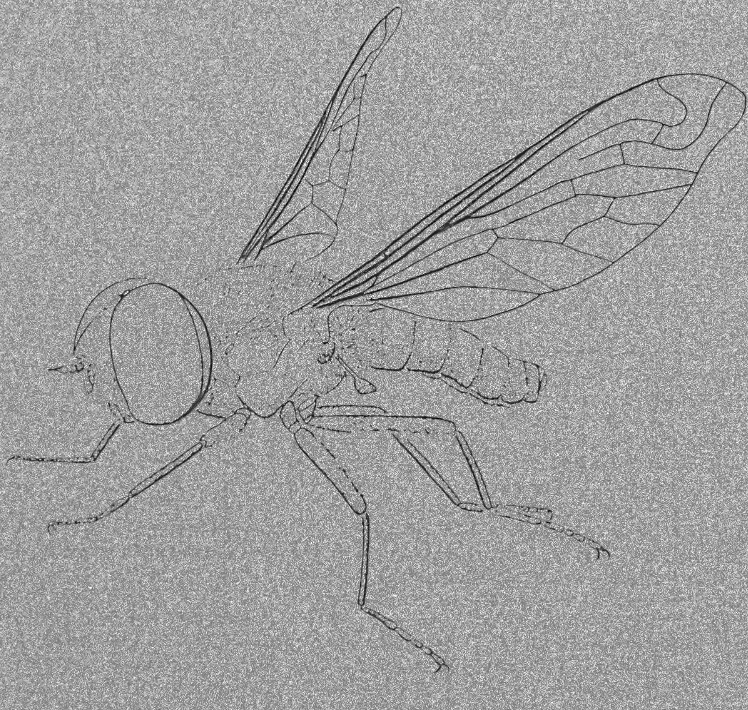
THE AUSTRALIAN

Entomologist

published by

THE ENTOMOLOGICAL SOCIETY OF QUEENSLAND



Volume 22, Part 2, 31 August 1995

Price: $5.00 per part

: THE ENTOMOLOGICAL SOCIETY OF QUEENSLAND

ISSN 1320 6133

THE AUSTRALIAN ENTOMOLOGIST

The Australian Entomologist (formerly *Australian Entomological Magazine*) is a non-profit journal published in four parts annually by the Entomological Society of Queensland. It is devoted to entomology of the Australian region, including New Zealand, Papua New Guinea and islands of the south-western Pacific. Articles are accepted from amateur and professional entomologists. The journal is produced independently and subscription to the journal is not included with membership of the Society.

Subscriptions

Subscriptions are payable in advance to the Business Manager, The Australian Entomologist, P.O. Box 537, Indooroopilly, Qld, Australia, 4068.

For individuals: A$16.00 per annum Australia
A$20.00 per annum elsewhere

For institutions: A$20.00 per annum Australia.
A$23.00 per annum elsewhere

Cheques in currency other than Australian dollars should include an extra A$5.00.

ENTOMOLOGICAL SOCIETY OF QUEENSLAND

Membership is open to anyone interested in Entomology. Meetings are normally held in the Department of Entomology, University of Queensland on the second Monday of March-June and August-December each year. Meetings are announced in the Society's News Bulletin which also contains reports of meetings, entomological notes, notices of other Society events and information on Members' activities.

Enquiries relating to the Society should be directed to the Honorary Secretary, Entomological Society of Queensland, C/- Department of Entomology, University of Queensland, Brisbane, Qld, 4072.

Sustaining Associates

Arrest-A-Pest Pty Ltd, Rhone-Poulenc Rural Australia Pty Ltd.

Cover: This undescribed species of Bombyliidae of the genus *Docidomyia* is from the Goldfields Region of Western Australia. The genus belongs to the subfamily Tomomyzinae, and has closest relatives in southern Africa and North America. Adults feed on nectar and pollen and the larvae are presumably parasitoids, as are most other Bombyliidae, although nothing is known of the life history of this subfamily throughout the world. Illustration by David Yeates.

Printed by Hans Quality Print, 20 Lyons Terrace, Windsor, Qld, 4030

NOTES ON THE HABITAT, FLYING SPEED AND BEHAVIOUR OF *AUSTROPHLEBIA COSTALIS* (TILLYARD) (ODONATA: AESHNIDAE) IN BRISBANE FOREST PARK, QUEENSLAND

PETER F. WOODALL

Department of Anatomical Sciences and Centre for Conservation Biology, University of Queensland, Brisbane, Qld, 4072

Abstract

During surveys in Brisbane Forest Park (1991-1994), *Austrophlebia costalis* was recorded from November to February. Most observations were from flowing streams in open or closed forest but two were next to a dry, rocky creek-bed in eucalypt open forest. Three dawn-to-dusk surveys in December, January and February indicated that *A. costalis* was active from 0600 to 1800 h EST with no marked crepuscular peaks in activity but low activity from 0900-1200 h EST. The mean speed of the hawking flight was 6.2 km/hr and that of fast flight was 17.7 km/hr. The fastest timed speed was 34.1 km/hr.

Introduction

Austrophlebia costalis (Tillyard) is one of the largest Australian dragonflies (abdomen 70 mm, hind-wing length 60-68 mm [Fraser 1960]) and its size, chocolate brown body and the dark brown bands running along the costal length of each wing make it quite distinctive. It has a wide distribution along the east coast of Australia (Watson *et al.* 1991) but little is known of its biology apart from the early observations of Tillyard (1916). However, it has received some international consideration (Hocking 1953, Corbet 1962) following the statements by Tillyard (1916, 1917) concerning its flight speed. This paper provides additional observations on its habitat preference, daily activity patterns and flight speed.

Study Area and Methods

Incidental observations were made during 12 km walked transects for avian surveys in Brisbane Forest Park, west of Brisbane, conducted twice a month from May 1991 to March 1994. The transects cover most of the major vegetation types of Brisbane Forest Park (Young 1982) including closed notophyll forest, closed microphyll forest, open eucalypt forest and woodland and they cross some of the many small streams draining the park, including those flowing east into Love Creek/Cedar Creek and Enoggera Creek.

More detailed observations were collected during dawn-to-dusk observations at Love Creek (27°19'S 152°45'E, 600 m asl) where the shallow, rocky stream flows in open forest with a mid-stratum of bangalow palm *Archontophoenix cunninghamiana*. Records of flight speed were made here using a stopwatch (accurate to 0.01 s) to time flights between prominent landmarks over stretches of the stream (7-11 m) measured using a rangefinder (accurate to 0.2 m at this distance). This relatively short distance was used because I found it very difficult to detect fast flying *A. costalis* at ranges greater than about 20 m in the conditions of low light intensity and it was essential to have a lead-in to prepare for timing prior to the timed and measured distance.

Results and Discussion

Habitat Selection

Most observations of this species were made at flowing streams in closed (Greene's Falls) or open forest (Love Creek) surrounded by dense vegetation. Nymphal exuviae identified as belonging to *A. costalis* were found at Love Creek, indicating that it does breed here. However, on two occasions (17.xii.1991, 28.xi1992) an adult was seen settled on shrubs adjacent to a dry rocky creek bed in eucalypt open forest, between Boombana and Jolly's Lookout, lacking palms or any other type of dense vegetation and having an understorey of grass. Water flows in this section of the creek only for a short period after heavy rainfall (pers. obs.) but further downstream it joins Enoggera Creek which has permanent water and is surrounded by a thin strip of closed forest.

Most previous descriptions of the habitat of this species from the Dorrigo Tableland, NSW and Mount Tambourine, Qld. (Tillyard 1916) related to flowing streams surrounded by dense vegetation (? closed forest) but, at Dorrigo, Tillyard (1916) reported flushing two newly emerged females from their perching sites "some hundred yards or more above the beginnings of a small gully". These observations indicate that *A. costalis* will occasionally move into more open, drier habitats away from the forest streams but the reasons for these movements require further investigation.

Daily Activity

Four dawn-to-dusk (0400 - 1900 h EST) surveys were made at Love Creek on 30.xii.1992, 27.i.1993, 12/13.ii.1993 and 26.xi.1993. A record of *A. costalis* activity was deemed to be a flight either up or down the creek past the observer. These were collected incidentally to a survey of avian calling activity but it is considered unlikely that any *A. costalis* were missed due to the other monitoring activity. Weather conditions during these days varied from overcast conditions with showers to bright sunny periods. Even during the sunny spells, 90-95% of the creek was in shade due to the canopy of palms. There was no obvious association between the weather and flight activity; *A. costalis* was recorded flying during both drizzle and sunny periods.

No *A. costalis* were recorded during the November survey but results from the other three days are presented in Fig. 1. There are records of *A. costalis* activity from throughout the day, apart from the first two hours of light and low activity from 1000 to 1200 h and there is no indication of any marked crepuscular peak in activity.

The only observations on the activity patterns of *A. costalis* are given by Tillyard (1916) who stated "The earliest time of day at which I saw this insect in flight (apart from occasionally disturbing resting females in the morning) was about 1 o'clock on a dull stormy day. They seldom fly at all until 4 pm but from that hour to sunset are particularly active". Other statements, possibly repeating those of Tillyard (1916), are given by Fraser (1960) "... probably mainly crepuscular"; Houston and Watson (1988) "...

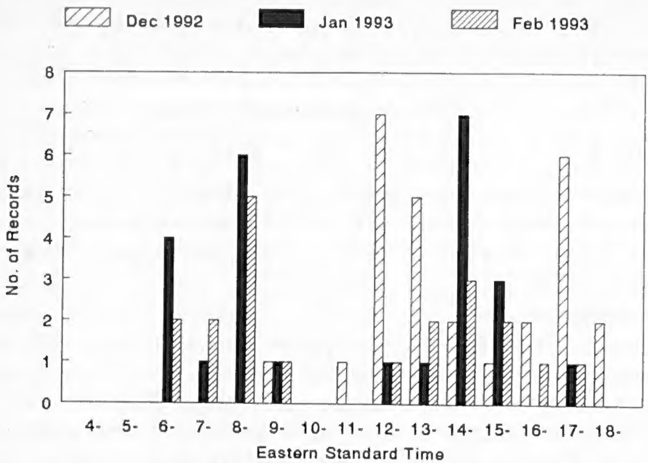


Fig. 1. Daily activity pattern for *Austrophlebia costalis* at Love Creek, Brisbane Forest Park.

tending to crepuscular activity"; Watson *et al.* (1991) "... probably mainly crepuscular". At Love Creek, *A. costalis* is active for a far greater period of the day than these statements imply.

Speed of Flight

During observations at Love Creek, two types of flight were observed. One was a slower hawking flight with a variable number of lateral deviations or 'jinks' while the other was a fast direct flight, with no lateral deviations. The mean speed of the hawking flight was 6.2 km/hr (s.e. 1.0, n = 9) and the mean speed of the fast flight was 17.7 km/hr (s.e. 2.5, n = 11). The fastest timed flight was of 34.1 km/hr but one untimed flight was considerably faster.

The first account of the flying speed of *A. costalis* was given by Tillyard (1916) "The distance from my watching-place, ... to the ledge of rock over which the swift-flying males first appeared was, as near as I could judge, about eighty yards. From the time they first appeared to the time they passed me was barely sufficient for me to grip my net and steady myself to strike. At the most it could only have been two or three seconds, which gives these insects the incredible speed of about sixty miles an hour". This description indicates that neither the distance nor the time were measured but it was repeated by Tillyard (1917) as, "I had the opportunity once of timing it over a measured stretch of between eighty and ninety yards. The distance was covered in three seconds; so that this Dragonfly can fly at the rate of nearly sixty miles per hour!" [c. 100 km/hr]. This value has been cited subsequently as exceptionally fast but its validity has been questioned by Corbet (1962) following calculations of Hocking (1953) which indicated a theoretical maximum air-speed of 57 km/hr and a maximum sustained flight of 38 km/hr

for *A. costalis*. However, Hocking (1953) acknowledged that factors such as a following wind, downhill flight or the short distance could account for the difference. It is also obvious that the original description by Tillyard (1916) suggests far less precision than his subsequent statement (Tillyard 1917) and a difference in the estimated time of one or two seconds would cause a major difference to the final calculations of speed. The fastest speeds timed from Love Creek were much lower than those of Tillyard (1916, 1917) and more in line with the calculations of Hocking (1953) but my (untimed) observation indicated that *A. costalis* is capable of even faster speeds, at least over short distances.

General Behaviour

As Tillyard (1916) recorded, the species generally hangs vertically from streamside vegetation, often on the underside of a tree-fern frond and in this position with its dark coloration it is particularly difficult to see. Flying activity of adults has been recorded from November to February in Brisbane Forest Park, slightly extending the period of November to January given by Fraser (1960) but Tillyard (1916) also records two specimens taken in February. Tillyard (1916) records females ovipositing into small submerged logs or twigs. This was preceded by a "quick to-and-fro" movement of the abdomen which he interpreted as a sawing of the wood with the projecting teeth of abdominal segment 10 to open the wood. I twice saw females probing with the end of their abdomen into a fallen branch or the roots/rhizomes exposed at the edge of the river bank. These were both out of water; in the case of the branch it was above a small pool and in the case of the roots it was within a few cm of the water's edge. I cannot be certain that actual oviposition took place in either instance.

Acknowledgment

I am grateful to an anonymous referee for useful comments on the MS.

References

CORBET, P.S. 1962. *A biology of dragonflies.* Pp. 247. H.F. & G. Witherby, London.

FRASER, F. C. 1960. *A Handbook of the Dragonflies of Australia.* Pp. 67. Royal Zoological Society of New South Wales, Sydney.

HOCKING, B. 1953. The intrinsic range and speed of flight of insects. *Transactions of the Royal Entomological Society of London* **104:** 225-345.

HOUSTON, W.W.K. and WATSON, J.A.L. 1988. Odonata. *In Zoological Catalogue of Australia.* Vol. 6. Pp. 33-132. (Vol. Ed. W.W.K. Houston). Australian Government Publishing Service, Canberra.

TILLYARD, R.J. 1916. Life -histories and descriptions of Australian Aeschninae; with a description of a new form of *Telephlebia* by Herbert Campion. *Journal of the Linnean Society* (Zoology) **33:** 1-83.

TILLYARD, R.J. 1917. *The Biology of Dragonflies.* Pp. 396. Cambridge University Press, Cambridge.

WATSON, J.A.L., THEISCHINGER, G., and ABBEY, H.M. 1991. *The Australian Dragonflies.* Pp. 278. CSIRO, Canberra.

YOUNG, P. 1982. Vegetation Classification *In*: Vegetation Map - Brisbane Forest Park. Department of Mapping and Surveying, Brisbane.

THE LIFE HISTORY OF *ZETONA DELOSPILA* (WATERHOUSE) (LEPIDOPTERA: LYCAENIDAE)

M.F. BRABY*

Department of Zoology, James Cook University of North Queensland, Townsville, Qld. 4811

Abstract

The early stages of *Zetona delospila* (Waterhouse) are described from northern Queensland. Larvae feed at night on hemi-parasitic vines, *Cassytha filiformis* L. in Queensland and *C. glabella* R.Br. in coastal Western Australia, which grow over tussocks of *Triodia* or *Spinifex*. The distinctive pupal morphology provides support for the species current placement within the Candalidini. Egg and larval morphology and the food plants of *Z. delospila* suggest a close relationship to the *Candalides (Erina)* group of *Cassytha*-feeding species.

Introduction

Zetona delospila (Waterhouse) is an uncommon butterfly confined to the dry tropical region of northern Australia. It has a wide, sporadic distribution with most records from the far north-west, where it ranges from Broome and the Edgar Range south-west of Kimberley to the Ord River at Queens Islet in Western Australia (Common 1981, Common and Waterhouse 1981, Dunn and Dunn 1991). In Queensland the species is known from five disjunct areas: (1) 30 km W of Fairview (Monteith and Hancock 1977); (2) Porcupine Gorge National Park 70 km NW of Hughenden (Valentine 1981, Valentine and Johnson 1982); (3) 9 km WSW Torrens Creek and on the Burra Range 18 km ENE of Torrens Creek about 140 km SW of Charters Towers (Braby 1994); (4) on the Selwyn Ranges at Mt. Elliot Mine approximately 140 km SE of Mt. Isa (1 ♀, 5.iii.1993) and at Selwyn Mine approximately 160 km SE of Mt. Isa (1 ♂, 20.iv.1993) (T.A. Woodger, pers. comm.); (5) Johnson Creek about 70 km NW of Mt. Isa (2 ♂♂, 2 ♀♀, 18.v.1993) (A. Eggleton, pers. comm.).

Adults of this distinctive lycaenid fly close to the ground amongst grass and low shrubs (Common and Waterhouse 1981), often in open sandy areas or on sandstone escarpments among clumps of spinifex (*Triodia*). The early stages and general biology have not been reported. The purpose of this paper is to document the life history, summarise available information on its biology and comment on its taxonomic relationships with related Candalidini. Most of the work described here is based on observations made on or near the Burra Range (20°43'S, 145°10'E) in northern Queensland during 2-3.v.1992 and 13-14.v.1993.

Early Stages

Food plants. Cassytha filiformis L. in Queensland (Voucher: Braby AQ 625005, Queensland Herbarium Indooroopilly), *C. glabella* R.Br. in coastal Western Australia (Lauraceae).

---

* *Present address: CSIRO Division of Entomology, GPO Box 1700, Canberra, A.C.T., 2601*

Egg (Fig. 1). Hemispherical, whitish-grey, surface deeply pitted; ridges of pits widely spaced, pits approximately hexagonal in shape; micropylar area depressed. Diameter 0.6 mm, height 0.4 mm.

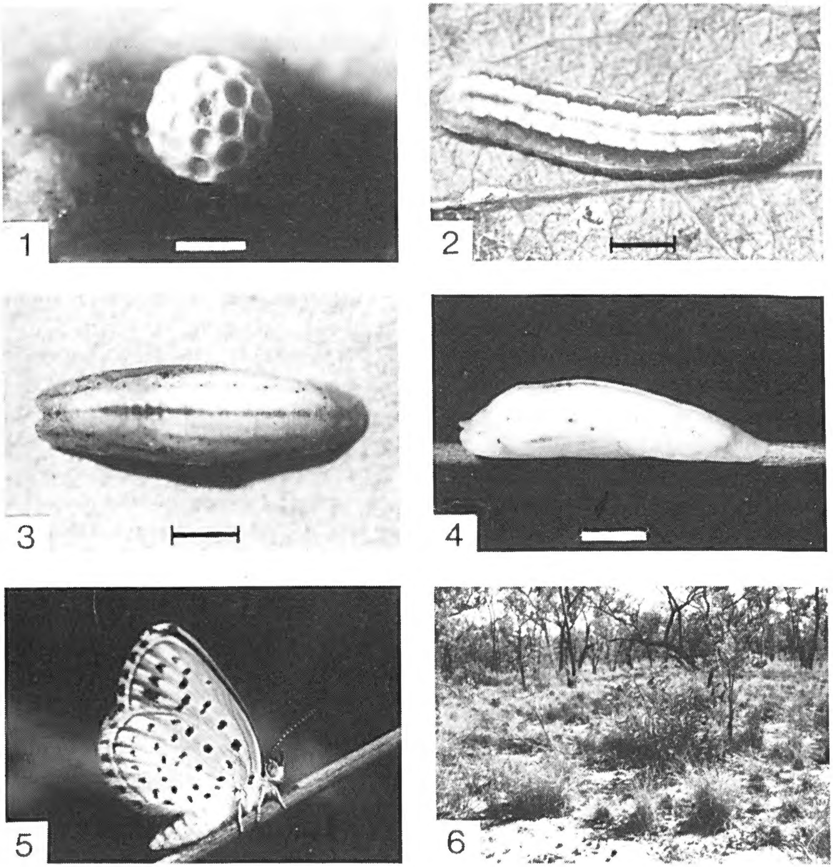
Final instar larva (Fig. 2). Thorax and abdominal segments 1-6 with red middorsal line and a broad whitish-yellow subdorsal band, edged below by a dark purple dorsolateral band; lateral surface green with a faint yellow ventrolateral line. Abdominal segments 7-10 green with pronounced reddish-purple middorsal line and a faint reddish-purple dorsolateral line; Newcomer's organ present on segment 7 but weakly developed; raised areas on segment 8 but organs not everted. Prothoracic and anal plates green, somewhat flattened; segments 9-10 narrower than segments 7-8; abdominal segment 10 distinctly U-shaped posteriorly. Head light brown, hidden beneath prothorax. Body with numerous light brown setae; spiracles light brown. Length 11-12 mm.

Pupa (Figs. 3, 4). Elongate, pale cream-yellow with scattered small black dots, especially on head and thorax. Head and abdomen with weakly developed lateral flanges. Thorax with weakly developed dorsal ridge. A dark reddish-brown middorsal line on head, thorax and abdominal segments 1-7, more pronounced on metathorax and abdominal segments 1-2. Abdominal segments with pink dorsolateral line edged above white; wings with series of faint black longitudinal lines; two variable black lateral spots or patches on abdominal segments 1-2. Spiracles black. Attached to silken pad by anal hooks and central girdle. Length 10 mm, width 3 mm.

Observations

On the sandstone plateau of the Burra Range *Z. delospila* was limited to open areas which supported eucalypt woodland and a fairly dense ground cover of *Triodia pungens* R.Br. (Spinifex or Porcupine grass) (Fig. 6), upon which the food plant grew as a hemi-parasitic vine. Within these areas *Cassytha filiformis* occurred in relatively discrete dense patches, but elsewhere it did not appear to be common. Adults collected from the Selwyn Ranges, western Queensland, also were observed flying over patches of *Cassytha* that were parasitic on *Triodia pungens* (T.A. Woodger, pers. comm.). On the Burra Range *Z. delospila* occurred together with the more abundant *Candalides geminus* Edwards & Kerr and *C. erinus* (Fabricius), which was scarce. The early stages of *C. geminus*, however, were only located on the larger vine *Cassytha pubescens* R.Br.

On the Burra Range eggs of *Z. delospila* were found singly on the flower buds and young shoots of the food plant; on 3.v.1992, at 1100 h, a female was also observed to deposit an egg beneath the stem of the food plant which was tightly wrapped around a leaf of *Triodia*. Near Cable Beach, Broome, Western Australia, females were observed (on 20.v.1981) ovipositing on the flower buds and new growth of *Cassytha glabella* which was parasitising



Figs. 1-6. Life history of *Zetona delospila*: (1) dorsal view of egg; (2) dorsal view of final instar larva; (3, 4) dorsal and dorsolateral views of pupa; (5) adult female; (6) habitat at the Burra Range. Scale = 0.3 mm for Fig. 1; 2.0 mm for Figs 2-4.

Spinifex (D.P.A. Sands pers. comm.). On the Burra Range larvae were collected during the day by shaking clumps of *Triodia* which supported dense clumps of the food plant. In captivity the larvae fed only at night; during the day they possibly hide deep within the *Triodia* tussocks. Larvae were not attended by ants. Two pupal shells (both parasitised) were found attached to the stem of a small shrub festooned with the larval food plant: both pupae were orientated in an upright position and situated about 10 cm above the ground. No pupae were found amongst the leaf litter and debris despite extensive searching, although D.P.A. Sands (pers. comm.) located an empty pupal case in a stiff curled leaf near Cable Beach, Western Australia. In captivity, the duration of the pupal stage varied from 13 to 16 days (n=2 ♀).

Adults (Fig. 5) were locally abundant on the Burra Range and nearly all specimens captured on 13-14.v.1993 were in fresh condition. They flew close to the ground, usually in close proximity to the food plant. Their flight was generally weak and somewhat resembled that of *C. erinus*. Adults were most active around midday, but only during sunny periods. During the early hours of the morning and late afternoon they were very inactive and settled mostly on stems of the *Triodia* tussocks for relatively long periods. Sun basking was observed during the cooler hours of the morning (from 0900 to 1000 h); butterflies would typically open their wings at 90-135° towards the sun whilst settled on small plants and other herbage near the ground. Females were apparently more numerous than males during 13-14.v.1993 (sex ratio of total captures: ♂/♀ 1:5, n=24). Butterflies were recorded feeding from a range of flowers: at Porcupine Gorge near Pyramid Lookout I took a female feeding on flowers of *Bursaria incana* Lindley (Pittosporaceae) at 1500 h on 1.v.1992; near Torrens Creek two adults were taken on flowers of *Waltheria indica* L. (Sterculiaceae) at 1045 h on 2.v.1992; and on the Burra Range both sexes were feeding commonly on flowers of *Cassytha pubescens* in company with *Candalides geminus* on 2-3.v.1992.

Discussion

Z. delospila has a rather disjunct distribution and until quite recently very few specimens were known; the species was considered rare by Common and Waterhouse (1972). Its patchy occurrence may reflect the patchy distribution of suitable food plant-grass associations (i.e. *Cassytha-Triodia/Spinifex*), particularly since many of these associations are confined to sandstone escarpments and open sandy areas which tend to be spatially patchy in nature. Moreover, within these habitats colonies of *Z. delospila* appear to be very localised.

In addition, *Z. delospila* appears to be quite seasonal and this also may partly account for the paucity of records. The known (combined) flight period is from March to August with one record from the Northern Territory in October (Monteith and Hancock 1977). Adults were not flying on the Burra Range in summer despite extensive searching during 12-13.ii.1994, although much of the habitat had been recently destroyed by fire. In Queensland, most sightings/captures have been in late autumn-early winter; in June 1977 on the *Triodia*-covered sandstone outcrops near Fairview (Monteith and Hancock 1977), in May 1980-81 at Porcupine Gorge National Park (Valentine 1981, Valentine and Johnson 1982), in May 1993 on the Johnson Creek north-west of Mt. Isa (A. Eggleton pers. comm.). Appearance of many fresh specimens in May 1992/93 at the Burra Range suggests the main emergence occurs in autumn.

The species *delospila* currently is placed in the monotypic genus *Zetona*, erected by Waterhouse (1938) after a long period of generic confusion. In his

original description of the species, Waterhouse (1903) provisionally placed *delospila* under *Zizera* Moore based on a single female, but noted that it was quite distinct from any described species that belonged to the 'grass-blues'. Waterhouse (1938) later suggested that *Zetona* may be related to *Lucia* Swainson, based on the superficial resemblance of the cell spots of the wing underside, but only five specimens were available then for comparison. Common and Waterhouse (1972) felt *Zetona* was still related to *Zizeeria* Chapman, *Zizula* Chapman and allied genera, but in a detailed study Eliot (1973) showed that the wing venation and male genitalia of *Zetona* were more closely related to *Candalides* Hübner sens. lat. and he placed the genus in the newly erected tribe Candalidini.

Evidence reported here on the early stages of *Z. delospila* clearly supports Eliot's view, particularly the shape and form of the pupa which is perhaps the most distinctive feature of the tribe. The pupae of these species are characterised by several features: (1) a lateral flange on the head, which may be strongly indented in the middle; (2) a lateral flange on the abdomen, which sometimes is upturned; (3) usually with a dorsal ridge on the thorax and abdomen; and (4) often with a pair of dorsal projections on the thorax. *Z. delospila* shares many of these characters, although the dorsal ridge is less pronounced on the thorax (and absent on the abdomen) and the flanges are not as strongly developed as in most other members, for example *Candalides cyprotus* (Olliff) (Atkins and Heinrich 1987). The pupal shape of *Z. delospila* somewhat resembles that of *C. acastus* (Cox) (see Fisher 1978, Fig. 81e), which is also elongate with a relatively narrow abdomen. Structurally, the pupa is perhaps closest to *C. geminus* which also has the lateral flanges less pronounced and the dorsal ridge weakly developed compared with *C. hyacinthinus* (Semper) and *C. erinus* (Braby unpubl. data).

The association of the early stages of *Z. delospila* with *Cassytha* spp. also indicates an ecological relationship with other members of *Candalides*, particularly those of the *Erina* Swainson species group (Tite 1963) which feed as larvae exclusively on *Cassytha* (e.g. Common and Waterhouse 1981, Fisher 1978). The early stages of *Z. delospila* are also very similar in morphology to these species. For example, the egg closely resembles that of *Candalides geminus* (which has the same shape and pit structure but is considerably larger, about 0.8 mm dia. (Braby unpubl. data)), but differs quite substantially from those of *Nesolycaena albosericea* (Miskin) and *C. absimilis* (Felder), both of which have triangular shaped pits with raised blunt projections at the pit junctions (Sands 1971, Braby unpubl. data). The larva of *Z. delospila* is rather colourful and similar in pattern to *C. geminus*. However, unlike *C. geminus*, *Z. delospila* lacks the raised dorsal reddish spots on abdominal segments 1 to 6 and does not possess the distinctive broken white dorsolateral line on the thoracic segments and abdominal segments 1 to 6 (Edwards 1980). Larvae of these two species are more brightly coloured than those of *C. hyacinthinus*, *C. erinus* and *C. acastus* which are green and less conspicuously striped.

Until a detailed comparative study is undertaken on the Candalidini, particularly the *Erina* (*Cassytha*-feeding) species group, *Z. delospila* is best retained in its current (separate) genus for the present.

Acknowledgments

I am very grateful to Tony Eggleton, Don Sands and Terry Woodger for providing their unpublished observations. Don Sands kindly commented on an earlier draft of the manuscript.

References

ATKINS, A. and HEINRICH, A. 1987. Notes on the biology of *Candalides cyprotus cyprotus* (Lepidoptera: Lycaenidae). *Australian Entomological Magazine* **14**: 45-48.

BRABY, M.F. 1994. Range extensions and distribution records for some butterflies in north-eastern Queensland - Part III. *Queensland Naturalist* **32**: 121-129.

COMMON, I.F.B. 1981. Part IV. Insects. Pp. 60-67. In McKenzie, N.L. (ed.). Wildlife of the Edgar Ranges area, south-west Kimberley, Western Australia. *Wildife Research Bulletin of Western Australia* No. 10.

COMMON, I.F.B. and WATERHOUSE, D.F. 1972. *Butterflies of Australia*. Angus and Robertson, Sydney.

COMMON, I.F.B. and WATERHOUSE, D.F. 1981. *Butterflies of Australia*. Revised Edition. Angus and Robertson, Sydney.

DUNN, K.L. and DUNN, L.E. 1991. *Review of Australian Butterflies: distribution, life history and taxonomy*. Parts I & III. Privately published by the authors, Melbourne.

EDWARDS, E.D. 1980. The early stages of *Adaluma urumelia* Tindale and *Candalides geminus* Edwards and Kerr (Lepidoptera: Lycaenidae). *Australian Entomological Magazine* **7**: 17-20.

ELIOT, J.N. 1973. The higher classification of the Lycaenidae (Lepidoptera): a tentative arrangement. *Bulletin of the British Museum of Natural History (Entomology)* **28**: 373-505.

FISHER, R.H. 1978. *Butterflies of South Australia*. Government Printer, South Australia.

MONTEITH, G.B. and HANCOCK, D.L. 1977. Range extensions and notable records for butterflies of Cape York Peninsula, Australia. *Australian Entomological Magazine* **4**: 21-38.

SANDS, D.P.A. 1971. The life history and taxonomic relationships of *Nesolycaena albosericea* (Miskin) (Lepidoptera: Lycaenidae). *Journal of the Australian Entomological Society* **10**: 290-292.

TITE, G.E. 1963. A revision of the genus *Candalides* and allied genera (Lepidoptera: Lycaenidae). *Bulletin of the British Museum of Natural History (Entomology)* **14**: 197-259.

VALENTINE, P.S. 1981. In search of *Zetona*. *Brolga. Newsletter of the Wildlife Preservation Society of Queensland, Townsville Branch*. **11**(5): 3-4.

VALENTINE, P.S. and JOHNSON, S.J. 1982. New records of Lycaenidae and Hesperiidae (Lepidoptera) from northern Queensland. *Australian Entomological Magazine* **9**: 1-3.

WATERHOUSE, G.A. 1903. Notes on Australian Rhopalocera: Lycaenidae. Part III. - Revisional. *Proceedings of the Linnean Society of New South Wales* **28**: 132-275.

WATERHOUSE, G.A. 1938. Notes on Australian butterflies in the Australian Museum. No. 1. *Records of the Australian Museum* **20**: 217-222.

DEVELOPMENT OF THE CAUDAL LAMELLAE IN *AUSTROARGIOLESTES ISABELLAE* THEISCHINGER AND O'FARRELL (ODONATA: MEGAPODAGRIONIDAE)

Ken Murray

41 Stanley St, Croydon Park, N.S.W., 2133

Abstract

The caudal lamellae in larval *Austroargiolestes isabellae* Theischinger & O'Farrell are described and illustrated. The appendages are strongly nodate for much of the larval development.

Introduction

Caudal lamellae, the hypertrophied paraprocts and appendix dorsalis are found at the end of the abdomen in larval damselflies. They are believed to function as external gills, aids to swimming and in enhancing displays (Johnson 1991). The development of these organs has been described in general terms by Tillyard (1917a, b) and MacNeill (1960). There was however, little information on caudal lamellae in the Megapodagrionidae and the development of the Australian megapodagrionids remained undescribed.

Tillyard (1917a) described and figured the lamellae of the final instars of two Australian species of *Argiolestes*. He remarked on the unusual dorso-ventrally flattened structure of these organs in Australian Megapodagrionidae, a unique feature in his experience. Although Tillyard never saw the early stages he concluded that the lamellae showed evidence of this type originating from a two-jointed form. This supposition is confirmed in the observations presented here.

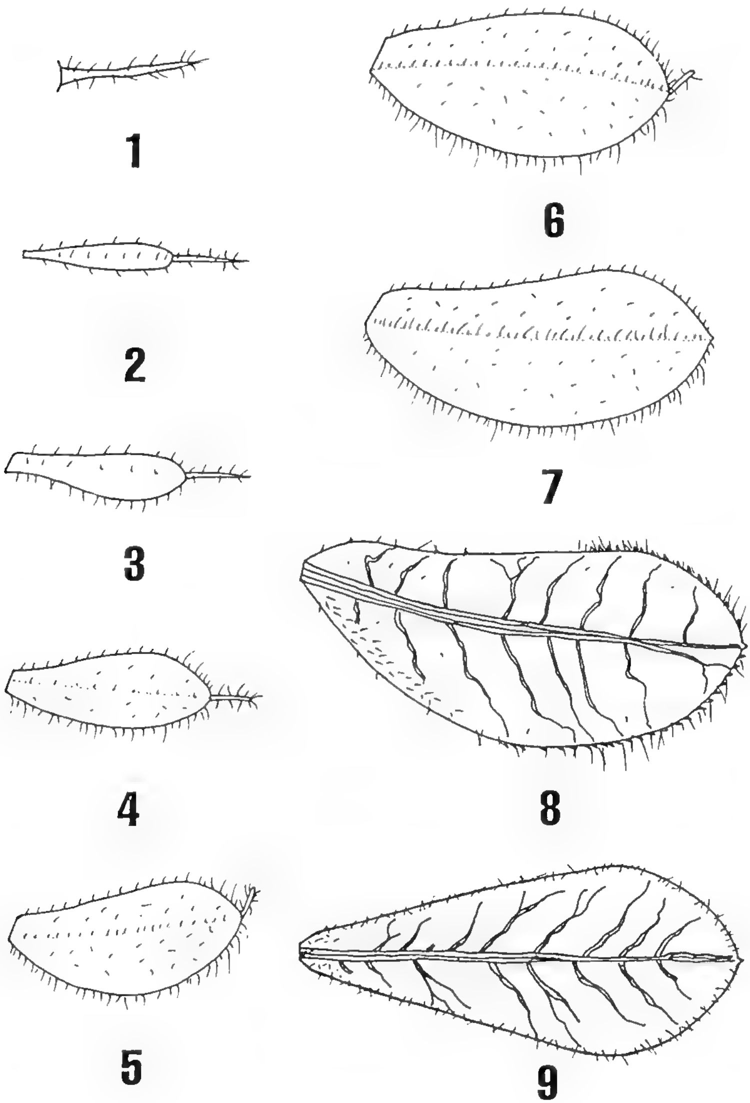
Methods

Exuviae of *Austroargiolestes isabellae* Theischinger & O'Farrell were collected during the rearing of this species (Murray 1992). Lamellae of instars 2-8 were studied on exuviae placed in a small Petri dish containing water. Final stage lamellae were removed from one exuvium and mounted on slides with Euparal. Drawings were made using a 'Vixen' stereo-microscope.

Results

The first instar (prolarva) was not seen and observations began with second-instar larvae. The morphology of the second-instar larva is remarkably uniform throughout the Zygoptera and the caudal lamellae of *A. isabellae* had the characteristic single-segmented style-like form, covered with setae (Fig. 1).

At the moult to the third instar the caudal lamellae became strongly nodate, appearing two-segmented, with a club-shaped basal and a style-like distal portion (Fig. 2). Both portions were of almost equal length. Widely spaced small setae marked the lateral carina and fringed the margin of the proximal



Figs 1-9. Development of the caudal lamellae in *Austroargiolestes isabellae*, dorsal view. All except Fig. 9 are of the left lamella: (1) single-segmented style-like appendage of second instar; (2) two-segmented (nodate) appendage of third instar; (3-6) nodate form in fourth to seventh instars; (7) penultimate instar; (8) final instar; (9) median lamella of final instar. (Not to scale).

portion. A scattering of setae was present over the surface. In early instars lamellae were spread in the usual way and later they were held horizontally.

Through subsequent moults the basal portion of the lamellae grew and became progressively more flattened and leaf-like in appearance. There was a gradual increase in setae on the lateral carina and about the margins. Both short and long setae occurred, the latter concentrated around the more rounded margins of the segments and on the lateral carina, especially through the later stages of development.

In contrast with the expansion of the basal portion, the style-like distal portion shortened (in absolute terms) with each moult, reducing in relative size from nearly half the length of the basal portion in the fourth instar (Fig. 3) to approximately one quarter in the fifth instar (Fig. 4) and thereafter was minute in comparison with the basal portion (Figs 5, 6). The style was lost completely by the penultimate instar (Fig. 7), being replaced by a small tapering tip to the basal portion. This pointed tip in turn was lost at the moult to the final instar when lamellae were subequal and uniformly rounded at the tip. The lateral lamellae were narrow at the base and broader distally and were asymmetrical about their long axis, with the more convex margin of each lamella held outermost (Fig. 8). The median lamella was symmetrical in shape, with lateral margins mostly straight and expanding from a narrow base to a broader distal end (Fig. 9). In living animals the median lamella was held at a slight angle to the laterals when viewed laterally.

Discussion

The Megapodagrionidae have a circumtropical distribution but both the higher taxonomic positioning of and relationships within the family are very uncertain (Houston and Watson 1988). Australian forms are characterised by the unusual dorso-ventral flattening and horizontal positioning of the caudal lamellae of the larvae. Confirmation that *A. isabellae* develops through a highly nodate saccoid stage may throw light on the relationships between the Australian Megapodagrionidae and other problematic taxonomic groups in the region.

Acknowledgments

I thank Dr R.J. Rowe, Department of Zoology, James Cook University, Townsville for generous assistance with the manuscript and one anonymous referee for helpful comments. Thanks also to Max Moulds, Australian Museum, for help with reference material.

References

HOUSTON, W.W.K. and WATSON, J.A.L. 1988. Odonata. In HOUSTON, W.W.K. (ed.) *Zoological Catalogue of Australia* Vol. 6, pp. 33-132.

JOHNSON, D.M. 1991. Behavioural ecology of larval dragonflies and damselflies. *Trends in Ecology and Evolution* 6: 8-13.

MACNEILL, N. 1960. A study of the caudal gills of dragonfly larvae of the suborder Zygoptera. *Proceedings of the Royal Irish Academy* **61**(B)(7): 115-140.

MURRAY, K. 1992. A note on the rearing of *Austroargiolestes isabellae* Theischinger & O'Farrell (Odonata: Megapodagrionidae). *Australian Entomological Magazine* **19**: 49-50.

TILLYARD, R.J. 1917a. On the morphology of the caudal gills of the larvae of zygopterid dragonflies. Part i (General morphology) and Part ii (Studies of the separate types). *Proceedings of the Linnean Society of New South Wales* **42**: 31-112.

TILLYARD, R.J. 1917b. On the morphology of the caudal gills of the larvae of zygopterid dragonflies. Part iii (Ontogeny) and Part iv (Phylogeny). *Proceedings of the Linnean Society of New South Wales* **42**: 606-632.

A GENITALIC ABERRATION OF *TRAPEZITES PRAXEDES* (HESPERIIDAE: TRAPEZITINAE) FROM NEW SOUTH WALES

A.F. ATKINS[1] and C.N. SMITHERS[2]

[1] *The University of Newcastle, Callaghan, N.S.W. 2308*

[2] *Australian Museum, College St., Sydney, N.S.W. 2000*

Abstract

A male specimen of the Australian endemic skipper *Trapezites praxedes* (Plötz) collected from the Barrington Range, central-eastern New South Wales, shows remarkable morphological differences in the genitalia. The entire structure is 'stretched' to a narrow, elongate form, although in detail each component is present and unaltered in proportion when compared with the genitalia of typical male specimens from nearby coastal localities. The comparative male genitalia are illustrated.

Introduction

The known distribution of *Trapezites praxedes* (Plötz) (see Sands *et al.* 1984) is eastern Victoria, coastal and montane New South Wales (Common and Waterhouse 1981), a few occurences in southern Queensland and an unconfirmed, isolated record from central Queensland (Dunn and Dunn 1991).

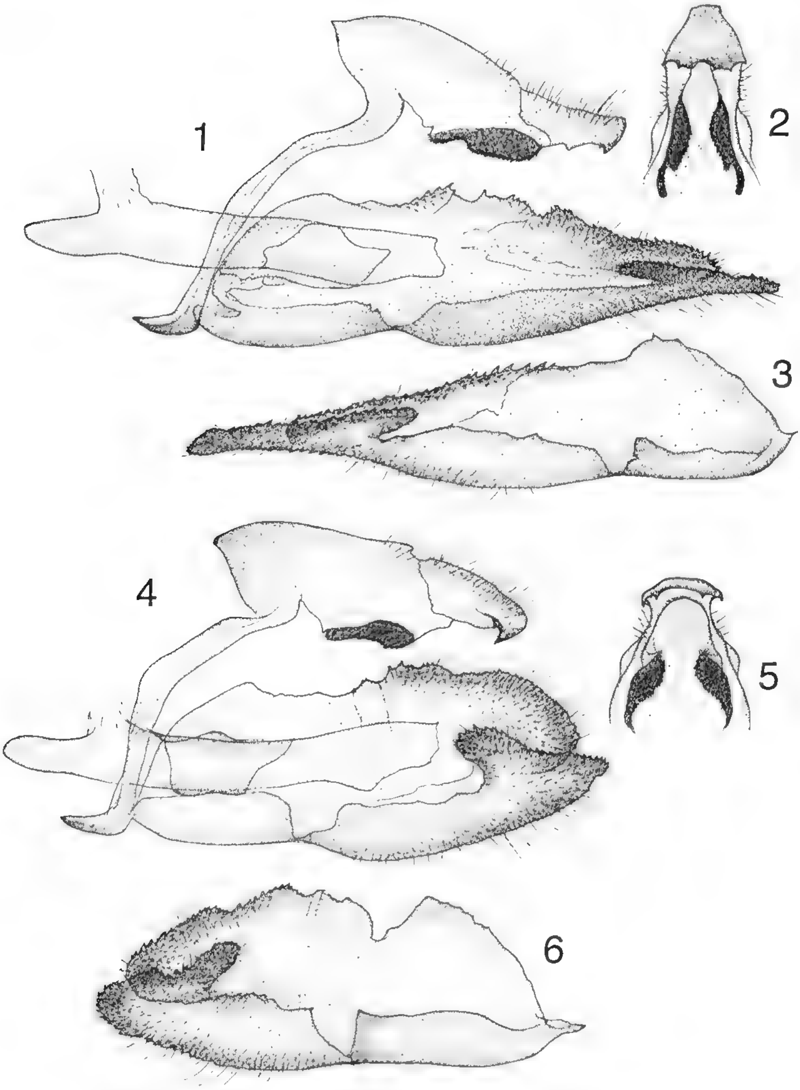
Trapezites praxedes is currently under taxonomic review by one of us (AA). The holotype is from the Sydney area ('Port Jackson') (Waterhouse 1932). Specimens very similar to the type occur along the coastal and near-coastal fringe of New South Wales, north to at least Port Macquarie (R. Mayo, pers. comm.) and in Queensland as far north as Fraser Island (pers. obs.). Another form, possibly a distinct taxon, is found in montane areas north from the Barrington district to at least southern Queensland (unpubl. data).

The recent capture of a male similar to the typical form, in the Barrington Range, is thus significant. The slightly worn specimen (now in the Australian Museum, Sydney) was collected on 24.iii.1991 at 'Tuglo' near Mt Royal, by A.S. Smithers. Dissection of the genitalia showed, however, that the structure was unlike that of any known trapezitine species.

Genitalia

All the components of the genitalia are present (Figs 1-3) and can be compared with those of the typical form (Figs 4-6), but the general structure, particularly the distal section, appears drawn out or stretched in an almost 'plastic' way.

Combined tegumen and uncus shorter than valva, laterally narrow and posteriorly elongate, curved downward but slightly upward at uncus which is rounded and blunt, slightly raised lateral flanges; vinculum normal, beak shaped; valvae somewhat asymmetrical (right valva narrower), shaped as in that of typical form, but narrow and elongate, tapered at posterior end with lower section (harpe) extending beyond upper to a pointed sclerotized



Figs 1-6. Male genitalia of *Trapezites praxedes*. (1-3) Aberration from Tuglo, N.S.W.: (1) lateral view of inside right valva, aedeagus and uncus; (2) ventral view of uncus tip; (3) lateral view of inside left valva. (4-6) Typical form from Whitebridge, N.S.W.: (4) lateral view of inside right valva, aedeagus and uncus; (5) ventral view of uncus tip; (6) lateral view of inside left valva.

projection, a recurved flattened process on inner edge; aedeagus as in typical form but tapered posteriorly.

Discussion

Trapezites praxedes varies marginally throughout a range of biomes along the central coast of New South Wales. The skipper most frequently occurs in open, mixed woodlands with a heavy heath understory, from sea-level to 500 m, in areas where the larval foodplant *Lomandra* Labill. (especially *L. obliqua* [Thumb.]) is abundant (Atkins 1993). The locality at Mt Royal contains a mixed variety of forest types, especially wet sclerophyll and rainforest. The aberrant male specimen was collected at approximately 700 m, beyond the normal altitude of this form, but may have originated from sclerophyll woodlands on the lower foothills. To our knowledge, this is the first record of the typical coastal form from the Barrington area.

Only one other aberration of *T. praxedes* is known. In December 1967, A. Sibatani collected an unusual male specimen near Coffs Harbour, northern New South Wales, in which both upper and lower wing surfaces had broadly exaggerated maculations (Sibatani 1970). Sibatani stated "Its antennae, head (palpi missing), body, wing shape and genitalia (dissected) are similar to those of *Trapezites maheta praxedes* (Plötz)." It is interesting that both aberration and a comparative male specimen (collected in December 1968 at the same locality, Coffs Harbour), illustrated by Sibatani (1970), are in fact atypical of the coastal form of this species. Conversely, the Mt Royal aberration, in appearance, closely resembles male coastal specimens from the Hunter Valley district.

Acknowledgments

We thank Mr Ted Edwards, CSIRO, for alerting us to A. Sibatani's paper and for discussion. Our thanks also to Mr Michael Braby, Mr Rod Eastwood, Mr Russel Mayo and Dr Grant Miller for discussions on *T. praxedes* and to Dr David McAlpine of the Australian Museum, Sydney, for the loan of specimens.

References

ATKINS, A. 1993. Biological, behavioural, and distributional records of some butterflies from New South Wales. *Victorian Entomologist* **23**: 54-56.

COMMON, I.F.B. and WATERHOUSE, D.F. 1981. *Butterflies of Australia*. Revised Edition. Angus & Robertson, Sydney.

DUNN, K.L. and DUNN, L.E. 1991. *Review of Australian Butterflies: distribution, life history and taxonomy*. Privately published, Melbourne.

SANDS, D.P.A., MILLER, C.G., KERR, J.F.R. and ATKINS, A.F. 1984. The specific status of *Trapezites praxedes* (Plotz) (Lepidoptera: Hesperiidae): previously considered to be a subspecies of *T. maheta* (Hewitson). *Australian Entomological Magazine* **11**: 27-33.

SIBATANI, A. 1970. An aberrant form of *Trapezites maheta praxedes* (Plotz) (Lepidoptera: Hesperiidae) from New South Wales. *Journal of the Australian Entomological Society* **9**: 67-68.

WATERHOUSE, G.A. 1932. Australian Hesperiidae. II. Notes and descriptions of new forms. *Proceedings of the Linnean Society of New South Wales* **57**: 218-238.

Erratum

Atkins, A. 1994. A new genus *Herimosa* (Lepidoptera: Hesperiidae: Trapezitinae) and its relationship to the *Proeidosa* group of endemic Australian skippers. *Australian Entomologist* **21:** 143-152.

In paragraph 2, page 148, 'The adult males of three species of *Anisynta* (*A. sphenosema, A. cynone and A. tillyardi*) and *Antipodia* have a sex-brand (or stigma) on the upperside of the forewing' should read 'The adult males of two species of *Anisynta* (*A. dominula* and *A. monticola*) and *Antipodia* have a sex-brand..'.

RECORDS OF ACULEATE WASPS FROM FLOWERING SUBTROPICAL RAINFOREST TREES

G. WILLIAMS[1,2] and P. ADAM[1]

[1] *School of Biological Science, University of New South Wales, P.O. Box 1, Kensington, N.S.W., 2033.*

[2] *Entomology Department, The Australian Museum, 6-8 College Street, Sydney, N.S.W., 2000.*

Abstract

More than 88 species of aculeate wasps are recorded visiting flowers of 11 species of trees in lowland subtropical rainforest or rainforest - wet sclerophyll forest ecotone sites in northern New South Wales. The tiphiid subfamily Thynninae was the most diverse taxon with 31 species collected.

Introduction

Adult aculeate wasps feed on nectar (Naumann 1991, Houston 1984) and, in Australia, have been recorded visiting flowers of sclerophyllous plants (Brown 1987, 1989a, b; Armstrong 1979; Houston 1984; Hawkeswood 1981; Allsopp 1992; Webb 1989) and pollinating orchids (Armstrong 1979 and references therein). Apart from a record of the scoliid *Campsomeris tasmaniensis* (Saussure) as a pollinator of *Macadamia* (Proteaceae) (Vithanage and Ironside 1986) and aculeates as pollinators of *Neolitsea dealbata* (Lauraceae), *Litsea leefeana* (Lauraceae) and *Diospyros pentamera* (Ebenaceae) trees in tropical Queensland (House 1985), there are few plant-visiting records for higher wasps in Australian rainforests.

Methods

Wasps of the families Pompilidae, Scoliidae, Sphecidae, Tiphiidae and Vespidae were collected by hand-netting as they fed on tree blossoms in seven lowland subtropical rainforest sites (*sensu* Adam 1992) and two rainforest-wet sclerophyll ecotone sites in northeast New South Wales (Tables 1, 2). A description of the collection sites, their floristic composition and location is given in Williams (1993) and Williams and Adam (1991). Wasps were observed and collected during three seasons from late 1990 until early 1993. Only wasps that alighted on blossoms were included in the study. Representatives of each species were examined for the presence of pollen.

Twenty species of mass-flowering rainforest trees, possessing unspecialised entomophilous floral morphologies (see Williams and Adam 1994), were included in the study but particular species did not necessarily flower during each season. In addition, the flowering patterns of individual tree species and populations were seasonally heterogeneous so that it was not possible to equally replicate sampling effort. Phenological data on flowering will be published elsewhere.

Results and Discussion

The number of wasp species attracted to individual tree species is given in Table 1 and flower-visiting records in Table 2. More than 50 percent of the species listed in Table 2 were recorded from only 1 or 2 specimens. Aculeate wasps were not collected from nine of the 20 trees included in the study: *Cassine australis* (Celastraceae) (Manning Point), *Caldcluvia paniculosa* and *Schizomeria ovata* (Cunoniaceae) (Lorien Wildlife Refuge), *Elaeocarpus obovatus* (Lansdowne Reserve) and *E. reticulatus* (Elaeocarpaceae) (Lorien Wildlife Refuge), *Drypetes australasica* (Euphorbiaceae) (Manning Point), *Scolopia braunii* (Flacourtiaceae), *Cyptocarya microneura* (Lauraceae) and *Acradenia euodiiformis* (Rutaceae) (Lorien Wildlife Refuge).

Table 1. Number of wasp species recorded visiting plants. "*" indicates records from rainforest-wet sclerophyll forest ecotone sites, all other records from rainforest only.

Plant Taxa	Site	No. spp.
Alphitonia excelsa	Harrington	60
Tristaniopsis laurina	Wingham Brush	23
Tristaniopsis laurina	Lorien Wildlife Refuge*	13
Euroschinus falcata	Saltwater Reserve	10
Waterhousea floribunda	Wingham Brush	8
Euroschinus falcata	Harrington	6
Acmena smithii	Harrington	6
Alectryon coriaceus	Manning Point	6
Acmena smithii	Manning Point	5
Cuttsia viburnea	Lorien Wildlife Refuge	4
Acmena smithii	Woko National Park	4
Alphitonia excelsa	Kenwood Wildlife Refuge*	4
Diospyros australis	Lansdowne Reserve	3
Guioa semiglauca	Harrington	3
Waterhousea floribunda	Lorien Wildlife Refuge	2
Diospyros australis	Lorien Wildlife Refuge	1
Abrophyllum ornans	Lorien Wildlife Refuge*	1
Rhodomyrtus psidioides	Lorien Wildlife Refuge*	1
Alectryon coriaceus	Harrington	1

The number of wasp species varied between both plant taxa and collection sites (Tables 1, 2) and the total number of wasps recorded in Table 2 was not present at any single site. Tiphiidae was the most diverse family (n= *ca* 36 spp.) and *Alphitonia excelsa* (Rhamnaceae) flowers (in rainforest) at

Harrington were visited by the highest number of wasp species (n= >60). *A. excelsa* flowers are distinctive in that they produce a fetid odour rather than a sweet fragrance. At other species of flowering trees (and *A. excelsa* trees at Kenwood Wildlife Refuge) there were fewer aculeate wasps and, on these, the anthophilous insect fauna was generally dominated by mixed pollinator guilds principally comprising bees, Diptera, Coleoptera and Thysanoptera. Aculeate wasps occasionally occurred in large numbers on flowering trees (e.g., *Alphitonia excelsa* at Harrington) but did not appear to disturb co-foraging native bees.

All the aculeates examined carried pollen conspecific with that of the flowers from which they were collected; however, individual pollen loads varied and frequently contained pollen of more than one species, indicating that individual wasps may not exhibit foraging fidelity. Data in Table 2 also indicate a general lack of fidelity. Large wasps may undertake relatively long-distance interplant flights exceeding 200 m (G.Williams, pers. obs.) and potentially contribute to out-crossing in subtropical rainforest tree populations, which typically consist of widely scattered individuals.

Few studies have addressed the contribution of anthophilous wasps to the breeding systems of rainforest plants. However, several ecological studies provide data on wasps as flower visitors in non-rainforest plant communities. Petanidou and Ellis (1993), in a 30 ha Greek 'phrygana' shrubland plot, collected 21 species of Sphecidae and 15 species of Vespidae. Heithaus (1979) collected Pompilidae (12 spp.), Scoliidae (3 spp.), Sphecidae (39 spp.), Tiphiidae (10 spp.) and Vespidae (52 spp.) from Costa Rican savannah and tropical deciduous and oak forests [these are similar to 'dry rainforest' under Australian closed forest classifications and were regarded as rainforest by Schimper (1903)], but >50 percent of species were represented by only 1 or 2 individuals. Inoue *et al.* (1990) recorded Scoliidae (1 sp.), Sphecidae (16 spp.) and Vespidae (11 spp.) from a Japanese temperate deciduous forest and Kato *et al.* (1990) recorded Sphecidae (10 spp.) and Vespidae (5 spp.) from Japanese primary beech forest (presumably in these forests the pollinators are understorey specialists as the canopies are wind pollinated). Vespidae (5 spp.) and Sphecidae (2 spp.) were collected by Kato *et al.* (1993) from flowers in Japanese cool-temperate subalpine forests and meadows.

In comparison with the records of Heithaus (1979), Inoue *et al.* (1990) and Kato *et al.* (1990, 1993), Tiphiidae were well represented in our study region and comprised approximately 41 percent of the wasp diversity (species richness: n= >88 spp.). However, this at least in part may be due to the greater representation of tiphiids in Australia; Tiphiidae constituted <8% of wasp taxa recorded by Heithaus (1979) from neotropical habitats. Most of the tiphiids collected by us were Thynninae, which is a diverse and abundant subfamily in Australia and occurs widely on Australian sclerophyllous plants (Hawkeswood 1981; Brown 1987, 1989a, b; Armstrong 1979; Keighery

1975). However, Inouye and Pyke (1988) did not record thynnines visiting the 43 species of alpine flora they observed in Kosciusko National Park, southern New South Wales. In Australian lowland subtropical rainforest and adjoining ecotonal forests, Thynninae may be a significant component of the anthophilous wasp community, which in palaearctic, nearctic and neotropical forests is dominated by Sphecidae and Vespidae.

Table 2. Aculeate wasps collected from flowers of rainforest trees. (number in parentheses = number of species).

Plant Species

1 - *Euroschinus falcata* (Anacardiaceae). 2 - *Diospyros australis* (Ebenaceae).
3 - *Abrophyllum ornans* (Escalloniaceae). 4 - *Cuttsia viburnea* (Escalloniaceae).
5 - *Acmena smithii* (Myrtaceae). 6 - *Rhodomyrtus psidioides* (Myrtaceae).
7 - *Tristaniopsis laurina* (Myrtaceae). 8 - *Waterhousea floribunda* (Myrtaceae).
9 - *Alphitonia excelsa* (Rhamnaceae). 10 - *Alectryon coriaceus* (Sapindaceae).
11 - *Guioa semiglauca* (Sapindaceae).

Sites

A - Harrington (32°52'30"S, 152°41'00"E).
B - Manning Point (31°53'30"S, 152°40'00"E).
C - Saltwater Reserve (approx. 12 km SE of Taree) (32°00'30"S, 152°33'45"E).
D - Lansdowne Reserve (0.5 km SE Lansdowne) (31°47'30"S, 152°32'30"E).
E - Lorien Wildlife Refuge (3 km N Lansdowne: 2 sites) (31°45'00"S, 152°32'30"E).
F - Kenwood Wildlife Refuge (4 km NNW Lansdowne) (31°44'45"S, 152°31'30"E).
G - Wingham Brush (Wingham) (31°52'40"S, 152°22'00"E).
H - Woko National Park (approx. 24 km NNW Gloucester) (31°49'00"S, 151°47'00"E).

Month of Collection

N (Nov.), D (Dec.), J (Jan.), F (Feb.), M (Mar.).

Species	Plant/Site	Month
POMPILIDAE		
Chirodamus defensor Smith	8G	D
Chirodamus ?raptor Smith	7E	D
Chirodamus sp./spp.	7G(3), 8E, 9A(2)	NDJ
?*Chirodamus* sp./spp.	1C	N
Chryptocheilus bicolor (Fabricius)	7G	J
Chryptocheilus sp./spp.	9A(2)	JF
?*Chryptocheilus* sp./spp.	8G, 9A	DJ
Phanagenia fasciata Fabricius	1C	N
Platyderes collaris (Fabricius)	9A	F

Table 2 (cont.). Aculeate wasps collected from flowers of rainforest trees.

Species	Plant/Site	Month
SCOLIIDAE		
Campsomeris ?tasmaniensis (Saussure)	2E, 9A	DF
Campsomeris zonata Smith	7E	D
Scolia verticollis (Fabricius)	7E, 9A	DJF
Scolia ?verticollis (Fabricius)	7G	J
Scolia sp. nr. *verticollis* (Fabricius)	7G	J
Scolia sp./spp.	1C, 7G, 9A(3)	DJF
?Scolia sp./spp.	1C	D
SPHECIDAE		
Acanthosthethus sp./spp.	1A, 9A(2)	NJF
Bembicinus sp.	1A, 9A	NF
Bembix ?kamulla Evans and Matthews	7E	D
Bembix promontorii Lohrman	9A	J
Bembix sp./spp.	5B, 9A(2), 10B(2)	NDJF
Cerceris ?australis Saussure	7G	D
Cerceris minuscula Turner	7G	DJ
Cerceris sp./spp.	5H, 7E, 7G	DJ
Ectemnius reginellus Leclercq	9A	F
?Ectemnius sp.	8G(2), 9A	NDF
Larra sp.	9A	F
Pison sp.	9A	F
Sceliphron laetum (Smith)	7G, 9A	DF
Sericophorus sp.	9A	J
Sphex ephippium Smith	9A	F
Sphex fumipennis Smith	9A	F
Sphex globosus Smith	9F	F
Sphex ?luctuosus Smith	7E	D
Sphodrotes sp./spp.	1A, 9A(2), 9F	NJFM
?Sphodrotes sp./spp.	9A	F
Spilomena sp./spp.	4E(2), 8E	ND
Tachysphex sp.	1A, 1C, 9A(2), 9F	NDJF
?Tachysphex sp./spp.	9A(2), 10B(2)	DJFM
Williamsita sp./spp.	9A	J
TIPHIIDAE		
Anthoboscinae		
Anthobosca australasiae Guerin	8G	D
Anthobosca ?laevifrons (Smith)	1C	D
Anthobosca signata Smith	7E, 9A	DJF
Anthobosca ?signata Smith	7E	J
Diamminae		
Diamma bicolor Westwood	9A	J
Thynninae		
Acanthothynnus ater Brown	9A	F
Acanthothynnus ?ater Brown	9A	F
Agriomyia maculata Guerin	7G	J
Agriomyia manifesta Turner	5H	N

Table 2 (cont.). Aculeate wasps collected from flowers of rainforest trees.

Species	Plant/Site	Month
TIPHIIDAE (cont.)		
Thynninae (cont.)		
Agriomyia variegata Klug	8G	D
Dimorphothynnus dimidiatus (Smith)	5A, 5B, 9A, 11A	NF
Epactiothynnus tasmaniensis (Saussure)	9A	FM
Epactiothynnus ?tasmaniensis (Saussure)	5A	N
?Epactiothynnus sp.	9A	F
Eirone ?parca (Turner)	7G	J
Eirone sp. nr. *parca* (Turner)	5H, 7E, 7G, 8G	NDJ
Eirone schizorhina	7G	D
Eirone sp. nov.	7g	J
Hemithynnus apterus (Oliver)	5B	N
Hemithynnus rufiventris (Guerin)	7E	F
Lestricothynnus fravenfeldianus (Saussure)	7E	D
Rhagigaster ?denticulatus (Turner)	9F	F
Rhagigaster sp. nr. *kiandrensis* Guerin	5A, 9A, 11A	NDJF
Rhagigaster ?mutatus Turner	9A	F
Rhagigaster ?unicolor Guerin	7G, 8G	D
Thynnoturneria sanguinolentus (Turner)	7G	DJ
Thynnoturneria sp. nr. *umbripennis* (Smith)	7G, 9A	DJF
?Thynnoturneria sp.	9A	J
Tmesothynnus dispersus (Turner)	1C, 9A	NF
Tmesothynnus iridipennis (Smith)	7G	D
Zaspilothynnus sp. nr. *campanularis* (Smith)	9A	F
Zeleboria contigua (Turner)	5A	N
Zeleboria ?contigua (Turner)	5B, 9A, 11A	NDF
Zeleboria sp. nr. *contigua* (Turner)	1C	N
Zeleboria xanthorrhoei (Smith)	5A, 5B, 9A	NF
?Zeleboria sp.	9A	JF
VESPIDAE		
Polistinae		
Polistes humilis (Fabricius)	1C, 6E, 9A, 10B	N - M
Polistes ?humilis (Fabricius)	4E, 9A	DF
Polistes tepidus (Fabricius)	9A	F
Ropalidia sp./spp.	4E	D
Eumeninae		
Abispa splendida (Guerin)	7E, 9A	DM
Abispa ?splendida (Guerin)	7G	J
Bidentodynerus bicolor (Saussure)	7G	D
Deuterodiscoelius ephippium Saussure	2D	D
?Epiodynerus sp./spp.	2D(2), 7E, 9A	DJ
Leptomenoides sp./spp.	9A	J
Paralastor sp./spp.	1A(3), 1C, 3E, 5A, 5H, 9A(3), 10A, 10B,	NDJF
Pseudabispa confusa van der Vecht	7G, 9A	J

Acknowledgments

Dr Graham Brown (Museum and Art Gallery of the Northern Territory, Darwin) and Dr Ian Naumann and Ms Josephine Cardale (CSIRO, Canberra) are thanked for assistance with identifications. Dr Brown is additionally thanked for comments on our manuscript. The NSW National Parks and Wildlife Service are thanked for permission to collect in Woko National Park. Mr and Mrs R. Moylan and Miss L. Moylan (Lansdowne) kindly permitted studies on Kenwood Wildlife Refuge. One of us (GW) thanks the Australian Museum, Sydney and the Australian Entomological Society for grants in aid of research.

References

ADAM, P. 1992. *Australian Rainforests.* Oxford Monographs on Biogeography, (eds) George, W., Hallam, A. and Whitmore, T.C. Oxford University Press, Oxford: 293 pp.

ALLSOPP, P.G. 1992. Volatile compounds as attractants for *Campsomeris tasmaniensis* (Saussure) (Hymenoptera: Scoliidae). *Australian Entomological Magazine* **19**: 107-110.

ARMSTRONG, J.A. 1979. Biotic pollination mechanisms in the Australian flora - a review. *New Zealand Journal of Botany* **17**: 467-508.

BROWN, G.R. 1987. Revision of the Australian genus *Acanthothynnus* Turner (Hymenoptera: Tiphiidae). *Journal of the Australian Entomological Society* **26**: 181-188.

BROWN, G.R. 1989a. Revision of the Australian genus *Doratithynnus* Turner (Hymenoptera: Tiphiidae). *Journal of the Australian Entomological Society* **28**: 1-17.

BROWN, G.R. 1989b. The Australian genus *Encopothynnus* Turner (Hymenoptera: Tiphiidae). *Journal of the Australian Entomological Society* **28**: 255-266.

HAWKESWOOD, T.J. 1981. Notes on the pollination of *Nuytsia floribunda* (Labill.) R.Br. (Loranthaceae) and some literature reviewed. *The Western Australian Naturalist* **15**: 17-21.

HEITHAUS, E.R. 1979. Community structure of neotropical flower visiting bees and wasps: diversity and phenology. *Ecology* **60**: 190-202.

HOUSE, S.H. 1985. Relationships between breeding and spatial pattern in some dioecious tropical rainforest trees. Ph.D thesis, Australian National University, Canberra: 350 pp.

HOUSTON, T.F. 1984. Bionomics of a pollen-collecting wasp, *Paragia tricolor* (Hymenoptera: Vespidae: Masarinae), in Western Australia. *Records of the Western Australian Museum* **11**: 141-151.

INOUE, T., KATO, M., KAKUTANI, T., SUKA, T. and ITINO, T. 1990. Insect-flower relationship in the temperate deciduous forest of Kibune, Kyoto: an overview of the flowering phenology and the seasonal pattern of insect visits. *Contributions from the Biological Laboratory, Kyoto University* **27**: 377-463.

INOUYE, D.W. and PYKE, G.H. 1988. Pollination ecology in the Snowy Mountains of Australia: comparisons with montane Colorado, USA. *Australian Journal of Ecology* **13**: 191-210.

KATO, M., KAKUTANI, T., INOUE, T. and ITINO, T. 1990. Insect-flower relationship in the primary beech forest of Ashu, Kyoto: an overview of the flowering phenology and seasonal pattern of insect visits. *Contributions from the Biological Laboratory, Kyoto University* **27**: 309-375.

KATO, M., MATSUMOTO, M. and KATO, T. 1993. Flowering phenology and anthophilous insect community in the cool-temperate subalpine forests and meadows at Mt. Kushigata in the central part of Japan. *Contributions from the Biological Laboratory, Kyoto University* **28**: 119-172.

KEIGHERY, G.J. 1975. Parallel evolution of floral structures in *Darwinia* (Myrtaceae) and *Pimelea* (Thymeleaceae). *The Western Australian Naturalist* **13**: 17-19.

NAUMANN, I.D. 1991. Hymenoptera (wasps, bees, ants, sawflies). Pp. 916-1000 *in* CSIRO (ed.), *The Insects of Australia*. Melbourne University Press: Carlron.

PETANIDOU, T. and ELLIS, W.N. 1993. Pollinating fauna of a phryganic ecosystem: composition and diversity. *Biodiversity Letters* **1**: 9-22.

SCHIMPER, A.F.W. 1903. *Plant Geography upon a Physiological Basis*. (English translation). Clarendon Press, Oxford: 837 pp.

VITHANAGE, V. and IRONSIDE, D.A. 1986. The insect pollinators of *Macadamia* and their relative importance. *Journal of the Australian Institute of Agricultural Science* **52**: 155-160.

WEBB, G.A. 1989. Insects as potential pollinators of *Micromyrtus ciliata* (Sm.) Druce, Myrtaceae. *Victorian Naturalist* **106**: 148-151.

WILLIAMS, G.A. 1993. *Hidden Rainforests: subtropical rainforests and their invertebrate biodiversity*. New South Wales University Press & The Australian Museum, Sydney: 188 pp.

WILLIAMS, G.A. and ADAM, P. 1991. Rainforest remnants on headlands in the Manning Valley: their composition and conservation significance. *Wetlands (Australia)* **11**: 21-30.

WILLIAMS, G.A. and ADAM, P. 1994. A review of rainforest pollination and plant-pollinator interactions, with particular reference to Australian subtropical rainforests. *Australian Zoologist* **29**: 177-212.

ESTIMATION OF LARVAL INSTARS OF *HYPSIPYLA ROBUSTA* MOORE (LEPIDOPTERA: PYRALIDAE) BY LARVAL FRASS WIDTHS

J. MO and M.T. TANTON

Department of Forestry, The Australian National University, Canberra, ACT, 0200

Abstract
Frass widths are used to estimate the larval instars of *Hypsipyla robusta* Moore, a shoot borer of Australian red cedar *Toona australis* (F. Muell.) Harms. Based on the relationship betwen larval frass widths and larval head capsule widthe, the inter-instar boundaries of larval frass widths are calculated. The average frass widths of individual larvae are then compared with the boundaries to determine the larval instars. Ninety-three percent of laboratory larvae were assigned to their correct instars by frass widths and 87% of field larvae were estimated as in the same instars by frass widths as that determined by head capsule widths.

Introduction
The Cedar tip moth *Hypsipyla robusta* Moore is a serious pest of a number of Meliaceae species, including Australian Red Cedar *Toona australis* (F. Muell.) Harms.* (Beeson 1919). The larvae feed inside various tissues of the host plant, especially the growing shoots and pupate inside larval tunnels (Beeson 1919). Due to their cryptic nature, the development stages of larvae cannot be determined directly. As an indirect approach, this paper explores the possibility of using larval frass widths (FW) to estimate larval head capsule widths (HCW) and therefore larval instars. Such a technique may be used by forresters in fine-tuning the timing of control measures against this pest.

Frass of *H. robusta* larvae is found as conspicuous clumps at the openings to the larval tunnels (Roberts 1968). The inside of the tunnels, however, contains little frass (personal observation), suggesting that fresh frass is constantly being pushed out. It is therefore possible to relate the exterior frass to the current development stages of the larvae.

Methods
Larvae were obtained from a laboratory stock originating from mature larvae collected in a red cedar plantation in Macksville, NSW and maintained on the artificial diet of Couilloud and Guiol (1980). To enhance feeding, a small amount of macerated fresh young red cedar shoots was incorporated into the diet. Larvae from the original site were incorporated into the stock at least twice a year.

One hundred newly-hatched larvae were reared separately in glass vials (50x12 mm) until pupation. The instar of a larva was determined from the number of head capsules it shed. 1st to 3rd instar larvae were fed with the terminal parts of young shoots whilst the older larvae were supplied with cuttings

*The name *Toona ciliata* M. Roem may soon replace *Toona australis* (F. Muell.) Harms.

from the stouter parts of young shoots, in accordance with their natural feeding habits (personal observation). Food was replaced every 1-3 days, depending on the consumption rate and freshness of the tissue. Frass was removed daily from the glass vials. Rearing was in a room with temperature at 26±1°C and light period at 14L:10D. Humidity was not controlled, the room maintained humid by a vaporiser (KAZ Model 76).

At least 20 larvae at every instar were measured for HCW and FW, to the nearest 1/40 mm, under a stereo microscope fitted with an eyepiece scale. Due to the frequent rupture of head capsules in the last moult, the HCW's of the last instar larvae were replaced with the corresponding larval head widths just before pupation. For each larva measured for HCW, 20 air-dried frass pellets produced by that larva were measured and the mean FW calculated.

A separate set of data involving 30 larvae was collected in a red cedar plantation at Macksville, NSW, to test the effectiveness of FW in estimating larval instars in the field. The frass was transfered from the infested shoots to glass vials and then the shoots were dissected for larvae. The frass and the associated larvae were taken back to the laboratory and the larvae were further reared to obtain the head capsules for HCW measurements.

Results

Larvae moulted either 5 (32%) or 6 (68%) times before pupation, as noted previously by Atuahene and Souto (1983). A recent study by the authors showed 5- and 6-instar forms in larvae of both sexes (82% and 75% of 6-instar forms in males and females respectively), hence the variation in the number of larval instars is not likely to be sex dependant.

Larvae of the 5- and 6-instar forms showed similar HCW ranges in the 1st to 5th instars. Hence data were pooled and the joint mean and ranges are given in Table 1. Total separation was achieved by HCW for the first 4 instars, whereas the 5th and 6th instar larvae showed some overlapping in their HCW ranges. Further examination of the data showed that amongst the 25 5th instar larvae measured, only one had its HCW range fall within that of the 6th instar larvae. Thus HCW can still be considered a reliable predictor of larval ages. The inter-instar boundaries in HCW for any two non-overlapping instars were arbitrarily determined as the average of the maximum HCW of the former instar and the minimal HCW of the following instar, with that for the 5th and 6th instars as the minimum HCW of the 6th instar (Fig. 1).

Overlapping in FW started in the 4th instar and the relative within-instar variations (expressed as SE/mean) were consistently higher than that in HCW (Table 1). However, FW showed apparent positive correlation with HCW (Fig. 1) and the correlation was significant ($t=51.37$, $df=133$, $p<0.001$). The relationship was well fitted by linear regression (Fig. 1). Assuming the regression equation correctly described the true realtionship between HCW and FW, the inter-instar boundaries of FW obtained by supplanting the HCW

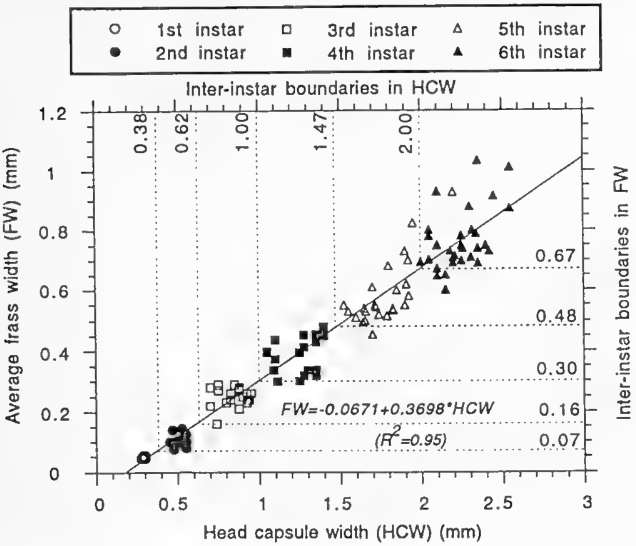


Fig. 1. The relationship between average frass width (FW) and larval head capsule width (HCW) in *Hypsipyla robusta*, with their inter-instar boundaries shown as dotted lines. Data from larvae reared on host plant material. (See text for details).

boundaries into the equation (Fig. 1) should perform equally well in delimiting larval instars. In effect, the percentages of correct estimations of larval instars by comparing individual FW's with the FW boundaries were 100% for the first 3 instars, 95% for the 4th instar, 76% for the 5th instar and 90% for the 6th instar. Overall, 93% of the measured larvae were assigned to their correct instars by their FW's. Most of the misclassifications occurred in the 5th and 6th instar, which is probably due to the overlapping of the HCW ranges of these two instars.

With field data, 26 larvae (87%) were assigned to the same instars by both HCW and FW. Two larvae that were assigned to the 5th instar by HCW were estimated as 6th instar by FW and 2 larvae that were determined as 5th instar by HCW were estimated as 4th instar by FW.

Discussion

The above analysis demonstrates that FW is a useful predictor of larval instars of *H. robusta*, especially for the first 4 instars. The degree of predictiveness is comparable with that of HCW. Since FW data are more easily accessed than HCW data, the FW approach appears promising. When applied to field situations, care should be taken to measure only those

Table 1. Larval head capsule widths (HCW) and frass widths (FW) in *Hypsipyla robusta*.

larval instar	head capsule width (HCW)		frass width (FW)	
	mean±SE(n) (SE/mean)	range	mean±SE(n) (SE/mean)	range
1st	0.29±0.01 (20) (0.03)	0.28-0.30 (0.05)	0.05±0.00 (20)	0.05-0.06
2nd	0.49±0.04 (20) (0.08)	0.45-0.53	0.10±0.02 (20) (0.20)	0.08-0.15
3rd	0.85±0.08 (20) (0.09)	0.70-0.95	0.25±0.03 (20) (0.12)	0.16-0.29
4th	1.24±0.13 (20) (0.10)	1.05-1.40	0.39±0.06 (20) (0.15)	0.30-0.48
5th	1.78±0.15 (25) (0.08)	1.53-2.20	0.59±0.11 (25) (0.19)	0.46-0.93
6th	2.25±0.15 (30) (0.07)	2.00-2.25 (0.13)	0.77±0.10 (30)	0.60-1.02

frass pellets of apparently larger sizes to minimise the possibility of accidentally including frass pellets produced at earlier developmental stages. The number of frass pellets required varies with instars. Under the assumption of normal distribution of FW, a minimal number of 16 frass pellets is recommended to keep the relative sampling error below 10%. Finally, the inter-instar boundaries of FW given here are based on larvae reared in an artificial environment. Although they were validated by one set of field data, further validation and possibly modification may be needed before widespread application of the method.

Acknowlegdment

We wish to thank Dr F.L. Bygrave (Division of Biochemistry and Molecular Biology, ANU) for providing the field study site.

References

ATUAHENE, S.K.N. and SOUTO, D. 1983. The rearing and biology of the mahogany shoot borer *Hypsipyla robusta* Moore (Lepidoptera: Pyralidae) on an artificial medium. *Insect Science and Application* **4**: 319-325.

BEESON, C.F.C. 1919. The life history of the Toon shoot and fruit borer, *Hypsipyla robusta* Moore (Lepidoptera: Pyralidae: Phycitinae) with suggestions for its control. *Indian Forest Records* 7(7): 1-216.

COUILLOUD, R. and GUIOL, F. 1980. The laboratory rearing of *Hypsipyla robusta* Moore. *Revue Bois et Forêts des Tropiques* n° **194**: 182-186.

ROBERTS, H. 1968. An outline of the biology of *Hypsipyla robusta* Moore, the shoot borer of Meliaceae of Nigeria, together with brief comments on two stem borers and one other lepidopteran fruit borer also found in Nigerian Meliaceae. *Commonwealth Forestry Review* **47**: 225-232.

A NEW DISTRIBUTION RECORD FOR *THECLINESTHES SULPITIUS* (MISKIN) (LEPIDOPTERA: LYCAENIDAE) IN THE NORTHERN TERRITORY AND NOTES ON THE LIFE HISTORY

C.E. MEYER[1] and D.N. WILSON[2]

[1] *10 Anne Clark Ave, Nicholls, ACT 2913*
[2] *PO Box 554, Palmerston, NT, 0831*

Abstract
New distribution records for *Theclinesthes sulpitius* (Miskin) in the Northern Territory are given and host plants identified.

Introduction

The salt pan blue *Theclinesthes sulpitius* (Miskin) is known to occur at Andoom Creek near Weipa, the Claudie River and from Cooktown south through coastal Queensland and New South Wales to Lake Wellington and Manns Beach, Victoria and at Berri in South Australia (Common and Waterhouse 1981, Dunn and Dunn 1991). There is no previous record of this butterfly occurring in the Northern Territory.

Discussion

Adults were first collected by the authors in December 1991 and February 1992 on Shoal Bay Peninsula near Darwin, where the butterfly was found flying around the salt bush *Halosarcia indica* (Willd.) (Family Chenopodiaceae). Subsequent collecting trips to the Cox Peninsula region, Elizabeth River and Leanyer swamps, near Darwin, located further colonies of the butterfly and another host plant, *Tecticornia australasica* (Moq.) (Family Chenopodiaceae).

Larvae were collected from the Shoal Bay Peninsula and Cox Peninsula sites and successfully reared to adults. The appearance of the early stages of this butterfly in the Northern Territory agrees with the description given in Common and Waterhouse (1981). Larvae on both host plants are extremely well camouflaged and difficult to locate. Larvae collected from the Cox Peninsula site were tended by numerous small black ants.

The four colonies found to date suggest that populations of the butterfly probably occur right across the coastal regions of the Northern Territory into the gulf country of Queensland.

Acknowledgments

We wish to thank Ian Cowie of the Northern Territory Herbarium, Palmerston for assistance in identifying the food plants and Rod Eastwood for his enthusiastic support during the February 1992 collecting trip.

References

COMMON, I.F.B. and WATERHOUSE, D.F. 1981. *Butterflies of Australia.* Pp xiv + 682. Angus and Robertson, Sydney.

DUNN, K.L. and DUNN, L.E. 1991. *Review of Australian Butterflies: Distribution, Life History and Taxonomy. Part III: Family Lycaenidae.* Pp 336-512. Privately published by the authors, Melbourne.

AN ACCUMULATIVE BIBLIOGRAPHY OF AUSTRALIAN ENTOMOLOGY
Compiled by G. Daniels

SAMSON, P.R.

1993 Illidge's ant-blue, *Acrodipsas illidgei* (Waterhouse and Lyell). Pp. 163-165 *in* New, T.R. (ed.), *Conservation biology of Lycaenidae*. IUCN: Gland.

SANDS, D.P.A.

1993 Overview of the invertebrate studies. Pp. 17-20 in *Cape York Peninsula Scientific Expedition Wet Season 1992 Report*. Vol. 1. Royal Geographic Society of Queensland Inc.: Fortitude Valley, Qld.

SCAMBLER, D.J.

1993 *Ischnauchen*, a new genus for *Aphiorhynchus costatus* McKeown (Coleoptera: Cerambycidae). *J. Aust. ent. Soc.* **32:** 193-195.

1993 Nomenclatural changes in the Calliprasonini (Coleoptera: Cerambycidae: Cerambycinae) with reinstatement of the Stenoderini. *J. Aust. ent. Soc.* **32:** 338.

SCHAEFER, C.W.

1993 Notes on the morphology and family relationships of Lestoniidae (Hemiptera: Heteroptera). *Proc. ent. Soc. Wash.* **95:** 453-456.

SCHAWALLER, W.

1993 The genus *Prostomis* (Coleoptera: Prostomidae) in Australia and adjacent regions. *Stuttg. Beitr. Naturk.* (A) **489:** 12 pp.

SCHEERMEYER, E.

1993 Overwintering of three Australian danaines: *Tirumala hamata hamata*, *Euploea tulliolus tulliolus*, and *E. core corinna*. Pp. 345-353 *in* Malcolm, S.B. and Zalucki, M.P. (eds.), Biology and conservation of the monarch butterfly. *Sci. Ser. Nat. Hist. Mus. Los Angeles County* **38:** xi + 419.

SCHNEIDER, M.A.

1993 Acalyptrate Diptera from Heathlands, Cape York Peninsula, Queensland. Pp. 211-220 in *Cape York Peninsula Scientific Expedition Wet Season 1992 Report*. Vol. 2. Royal Geographic Society of Queensland Inc.: Fortitude Valley, Qld.

SCHUTZE, M.

1993 Insect collecting trip and holiday to Hervey Bay, Queensland. *Vict. Ent.* **23:** 14-15.

SCHWARZ, M.P. and OVERHOLT, L.A.

1993 Methods for rearing allodapine bees in artificial nests (Hymenoptera: Anthophoridae). *J. Aust. ent. Soc.* **32:** 357-363.

SHATTUCK, S.O.

1993 Revision of the *Iridomyrmex purpureus* species-group (Hymenoptera: Formicidae). *Invert. Taxon.* **7:** 113-149.

1993 Revision of the *Iridomyrmex calvus* species-group (Hymenoptera: Formicidae). *Invert. Taxon.* **7:** 1303-1325.

1994 Taxonomic catalog of the ant subfamilies Aneuretinae and Dolichoderinae (Hymenoptera: Formicidae). *Univ. Calif. Publs Ent.* **112:** xix + 241.

1994 Taxonomy of the meat ants (*Iridomyrmex purpureus* species-group). *ANIC News* **4:** 6-7.

SHATTUCK, S.O. and McARTHUR, A.J.

1995 Generic placements of Australian ants described by W.F. Erichson, (Hymenoptera: Formicidae). *J. Aust. ent. Soc.* **34:** 121-123.

SIMMONS, L.W. and BAILEY, W.J.

1993 Agonistic communication between males of a zaprochiline katydid (Orthoptera: Tettigoniidae). *Behav. Ecol.* **4:** 364-368.

SIMPSON, G.B.

1993 Immature stages of *Nala lividipes* (Dufour) (Dermaptera: Labiduridae). *J. Aust. ent. Soc.* **32:** 51-57.

SINCLAIR, B.J.

1994 Homology and phylogenetic implications of male genitalia in Diptera - Lower Brachycera. *Ent. scand.* **24:** 407-432.

SMITHERS, C.N.

1993 Three new species of Psocoptera from New South Wales. *Gen. appl. Ent.* **24:** 39-45.

1993 A migration of *Delias harpalyce* (Donovan) (Lepidoptera: Pieridae) in the Hunter Valley, New South Wales. *Vict. Ent.* **23:** 28.

1993 New species and new records of Caeciliinae (Psocoptera: Caeciliidae) from the Mount Royal area, Hunter Valley, New South Wales, with key to the Australian species of *Caecilius* Curtis. *Gen. appl. Ent.* **25:** 15-21.

1994 Generic positions of Australian Psocoptera currently placed in *Paracaecilius* Badonnel and *Enderleinella* Badonnel (Insecta, Psocoptera: Caeciliidae). *Rec. Aust. Mus.* **46:** 125-129.

1995 Psocoptera from inflorescences of *Howea forsteriana* (C. Moore and F.J. Muell.) Becc. (Arecaceae) (thatch palm) on Lord Howe Island. *Gen. appl. Ent.* **26:** 1-8.

1995 *Psilopsocus mimulus* Smithers (Psocoptera: Psilopsocidae), the first known wood-boring psocopteran. *J. Aust. ent. Soc.* **34:** 117-120.

SPRADBERY, J.P.

1993 Queen brood reared in worker cells by the social wasp, *Vespula germanica* (F.) (Hymenoptera: Vespidae). *Insectes soc.* **40:** 181-190.

St CLAIR, R.M.

1993 Life histories of six species of Leptoceridae (Insecta: Trichoptera) in Victoria. *Aust. J. mar. freshw. Res.* **44:** 363-379.

ENTOMOLOGICAL NOTICES

Items for insertion should be sent to the editor who reserves the right to alter, reject or charge for notices.

NOTES FOR AUTHORS

Manuscripts submitted for publication should, preferably, be type-written, double spaced and in triplicate. Refer to recent issues for layout and style.

All papers will be forwarded to two referees and the editor reserves the right to reject any paper considered unsuitable.

Papers longer than eight printed journal pages will normally not be accepted.

Papers will be accepted only if a minimum of 100 reprints is purchased. Manuscripts occupying less than one printed page may be accepted without charge if no reprints are required. Charges are as follows: cost per printed page $25 for 100 copies. Page charges may be reduced at the discretion of the Publications Committee.

Illustrations: Black and white photographs must be submitted at the size they are to appear in the journal. Line drawings should be about twice their required size.

Address papers to: The Editor
The Australian Entomologist
P.O. Box 537
Indooroopilly, Queensland, 4068

THE AUSTRALIAN
Entomologist

Volume 22, Part 2, 31 August 1995

CONTENTS

ISSN 1320 6133